MN1010
GPS Receiver Module

1 Description

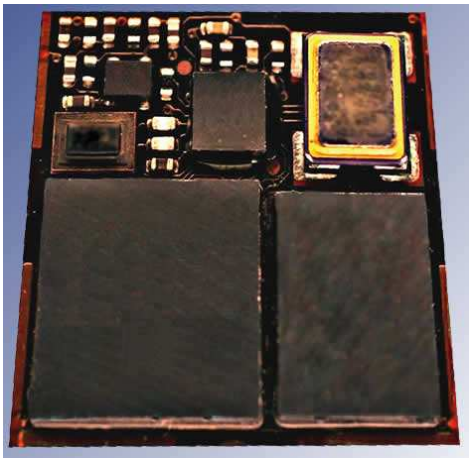
The Micro Modular Technologies MN1010 Global Positioning System (GPS) Receiver is a complete, 12-channel receiver intended for OEM applications that measures only 10mm by 10mm by 2mm. It features fast-acquisition hardware, integrated RF filtering, flash memory and a TCXO. The user needs only provide DC power and a GPS signal; the MN1010 will output the navigation solution in the widely-used NMEA-0183 format.

The 12-channel receiver allows all satellites in view to be tracked, providing an over-determined solution to minimize position jumps caused by individual satellite blockage. The fast-acquisition hardware design greatly reduces the time for signal acquisition when the receiver is initially powered up. The MN1010 requires a 1.8-volt supply and a separate 3-volt supply for the internal TCXO. For even further power reductions, the OEM design may switch power or use a commanded power-saving mode.

The MN1010 is supported by an evaluation kit, including software, along with reference designs to speed OEM development. The MN1010 is machine placeable by standard surface mount equipment and is available in tape and reel. A metal shield is provided for RF protection and for automated nozzle pickup.

1.1 Features

- Complete 12-channel GPS receiver including RF filtering, flash memory and TCXO
- Less than 75 mW total power consumption for extended battery life
- Ultra-small 10mm by 10mm by 2mm 36-pin LGA package for automatic placement in a high volume production environment
- Fast-acquisition design for rapid position determination under all startup and operating conditions.
- Industrial temperature operation (-40℃ to +85℃)
- Supports active antennas
- Standard NMEA-0183 serial messaging
- Pb free RoHS compliant
- Supported by hardware and software development kits



MN1010 (Lid Removed)

1.2 Block Diagram

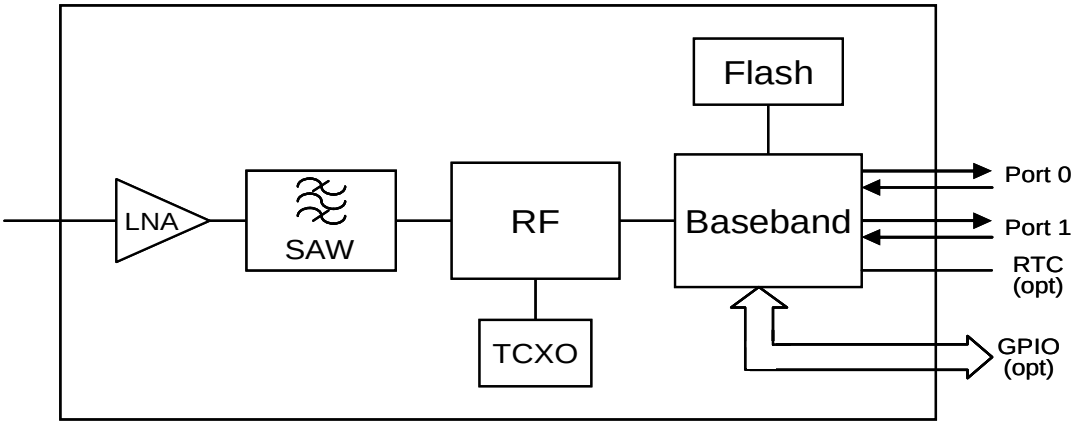


Figure 1 - MN1010 Block Diagram

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1.3 GPS Performance

Acquisition Time	Specification
Cold start TTFF (no time, no position, no ephemeris)	42 seconds (95% confidence)
Hot start TTFF (time, position and ephemeris, -130dBm signal)	8 seconds (95% confidence)
Fast Start TTFF (time accurate to 10msec, position and ephemeris, -130dBm signal)	<4 seconds (95% confidence)
Reacquisition	2 seconds (95% confidence)

Table 1 – Acquisition Performance

Positional Error	Accuracy
CEP (50%)	<3.0 meters

Table 2 – Positional Accuracy

Sensitivity	Typical
Tracking	-152 dBm
Acquisition (Cold Start, <5 minutes TTFF, 95% confidence)	-142 dBm

Table 3 – Sensitivity

Note: Above numbers are measured with an external 15 dB gain, 2 dB Noise Figure LNA.

2 Environmental

2.1 Operating

Temperature	-40℃ to +85℃
Humidity	Up to 95% non-condensing or a wet bulb temperature of +35℃, whichever is less
Altitude	-1000 feet to 60,000 feet

Table 4 – Operating Requirements

2.2 Storage

Temperature	-40℃ to +85℃
Humidity	Up to 95% non-condensing or a wet bulb temperature of +35℃, whichever is less
Altitude	-1000 feet to 60,000 feet
Shock	18G peak, 5 millisecond duration
Shock (in shipping container)	10 drops from 75 cm onto concrete floor

Table 5 – Storage Requirements

3 Electrical

3.1 Module Pin Descriptions

Pin	Name	Pin Definition
1	FREF	This pin should be left unconnected.
2	GND	GND
3	+1.8V	Power
4	$\overline{\text{SERBOOT}}$	This pin is a digital input. For normal operation, it is pulled high and the MN1010 will start executing code from on-board flash upon system reset or power-up. If $\overline{\text{SERBOOT}}$ is pulled active (low), then the MN1010 will enter boot mode upon reset or power-up to receive programming information in LOD format. This feature can be used to download a flash re-programmer into on-board RAM to update or change flash code. The state of the $\overline{\text{SERBOOT}}$ line is only read upon power-up or system reset. Refer to Section 4.1 for further information.
5	RX1	The MN1010 GPS Receiver Module implements two, full-duplex asynchronous serial UART ports. This signal is the input for the second UART and may be used to input commands or additional information to the receiver. In the idle condition, this pin is driven at logic 1. If the driving circuitry is powered independently of the MN1010, ensure this pin is not driven to logic 1 when the supply to the MN1010 is removed.
6	TX1	The MN1010 GPS Receiver Module implements two, full-duplex asynchronous serial UART ports. This signal is the output for the second UART. In the idle condition, this pin is at logic 1.
7	RX0	The MN1010 GPS Receiver Module implements two, full-duplex asynchronous serial UART ports. This signal is the input for the first UART and is normally used to input commands to the receiver in either binary or NMEA format depending upon the configuration of the receiver. In the idle condition, this pin is driven at logic 1. If the driving circuitry is powered independently of the MN1010, ensure this pin is not driven to logic 1 when the supply to the MN1010 is removed. As a second function, if this pin is pulled active (low), then RX0 receives LOD formatted programming information after power up or reset.
8	TX0	The MN1010 GPS Receiver Module implements two, full-duplex asynchronous serial UART ports. This signal is the output for the first UART and is normally used to output position, time and velocity information from the receiver in either binary or NMEA format depending upon the configuration of the receiver. In the idle condition, this pin is at logic 1.
9	1PPS	This pin outputs a one-pulse-per-second (1PPS) signal, and is active when the fix is valid.
10	+1.8V	Power
11	GND	GND
12	EXTRTC_INT2	If an external RTC IC (Seiko S-35390A) is used, connect this pin to the INT2 line of the RTC IC with a 10K pullup to +1.8V. If not used, leave open.
13	EXTRTC_SCL	If an external RTC IC (Seiko S-35390A) is used, connect this pin to the SCL line of the RTC IC with a 10K pullup to +1.8V. If not used, leave open.
14	N/C	No-connect

Pin	Name	Pin Definition
15	N/C	No-connect
16	EXTRTC_SDA	If an external RTC IC (Seiko S-35390A) is used, connect this pin to the SDA line of the RTC IC with a 10K pullup to +1.8V. If not used, leave open.
17	RTC_IN	The MN1010 provides for an optional RTC clock crystal to maintain time of day when the MN1010 is in a power sleep condition. If the hot start mode of operation is not required, then the real time clock is not needed and the crystal can be eliminated. If use of an internal RTC is desired, connect this pin to one side of a 32.768 KHz clock crystal and a shunt capacitor returned to the 1.8-volt DC supply. See Section 7 for additional information on the RTC crystal and recommended capacitors. If an external 32.768 KHz clock signal is available, it may be presented at this pin. The logic levels must match the logic levels of the MN1010. If an external RTC IC (Seiko S-35390A) is used this pin is connected to the INT1 line of the RTC IC.
18	RTC_OUT	The MN1010 provides for an optional RTC clock crystal to maintain time of day when the MN1010 is in a power sleep condition. If the hot start mode of operation is not required, then the real time clock is not needed and the crystal can be eliminated. If use of an internal RTC is desired, connect this pin to one side of a 32.768 KHz clock crystal and a shunt capacitor returned to the 1.8-volt DC supply, otherwise, leave this pin open. See Section 7 for additional information on the RTC crystal and recommended capacitors.
19	N/C	No-connect
20	VALID_FIX	This pin is used to indicate that the receiver has acquired a valid fix.
21	+1.8V	Power
22	N/C	No-connect
23	$\overline{\text{RESET}}$	To properly initialize the MN1010, a reset pulse must be supplied whenever the power supply is cycled. In addition, to prevent corruption of the on-board flash, the reset line should be pulled low whenever the 1.8-volt power supply falls out of tolerance, such as during a powering up or powering down of the host platform. The reset line should be held in the reset (logic low) state until 15 msec after the 1.8-volt and 3.0-volt power supplies have stabilized within proper tolerance.
24	GND	GND
25	+1.8VVCO	Power
26	+1.8VIF	Power
27	GND	GND
28	+1.8V for LNA	Power
29	GND	GND
30	ANT	RF Input: Connect to external antenna. See Section 3.3, RF Interface
31	GND	GND

Pin	Name	Pin Definition
32	$\overline{RFEN}$	This pin is a digital output enabling optional power control to the internal LNA and TCXO to reduce power consumption during SLEEP mode. This signal can be used to drive a FET or other suitable device to control power to the +1.8V LNA and +3V TCXO power pins. Orion software will drive this pin high when it receives a SLEEP command. This signal may then be used to disable the +1.8V LNA and/or +3V TCXO supplies. If control of these power supplies is not required, this pin should be left unconnected. During power up or processor reset, this pin is driven low.
33	+3V for TCXO	Power
34	+1.8VRF	Power
35	TPI	This pin is used for factory test and must be tied to ground through a 10Kohm resistor.
36	TPQ	This pin is used for factory test and must be tied to ground through a 10Kohm resistor.

Table 6 – MN1010 Pin Description

3.2 Power Supply

The MN1010 GPS Receiver Module is designed to operate from two supply voltages, the main voltage of 1.8 volts, and a secondary low current supply voltage of 3.0 volts for the internal TCXO.

The main 1.8 volts supply is fed into several voltage pins of the MN1010 GPS Receiver Module. Suitable decoupling and isolating of the individual power supply pins must be provided by external decoupling circuitry. In addition, optional power control may be added to select power supply pins to further reduce power consumption in standby and/or sleep modes. See the Reference Design Notes (Table 16 – Referenced Documents for MN1010 Data Sheet) for suggested decoupling values.

Voltage	1.8 VDC ± 5%
Current (typical)	35 mA
Current (maximum)	40 mA

Table 7 – Main Power Supply

Voltage	3.3 VDC ± 0.3 VDC
Current (typical)	2 mA
Current (maximum)	3 mA

Table 8 – TCXO Power Supply

3.3 RF Interface

3.3.1 RF Input

The MN1010 GPS Receiver Module accepts a standard GPS L1 signal from a passive or active antenna on the RF input pad of the module, which is pin 30, the ANT pin. If a passive antenna is used, no other circuitry is required. However, if an active antenna is required, then suitable means for powering the active antenna must be provided external to the MN1010 GPS Receiver Module. The RF input is isolated from DC levels to a maximum of ±15 VDC

If power is required for an active antenna, MMT recommends that a quarter wave stub be used to prevent disturbing the matching of the antenna and MN1010 module. The other end of the quarter wave stub should be AC grounded with a suitable microwave quality capacitor. See the Reference Design Notes (Table 16 – Referenced Documents for MN1010 Data Sheet) for more detail.

Signal Level	-151 dBm to -125 dBm typical
Frequency	L1 (1575.42 MHz)
Return Loss	Better than -5.5 dB
Noise Figure	7 dB typical
Impedance	50 ohms nominal

Table 9 – RF Signal Characteristics

The MN1010 GPS Receiver Module has a noise figure of 7 dB typically. With high quality high gain passive antennas this will provide adequate performance in low-cost environments. Using an external LNA of 2 dB NF and approximately 15 dB of gain will improve the performance of the receiver to work with a wider range of passive antennas.

3.3.2 Burnout Protection

The MN1010 GPS Receiver Module can accept signal levels up to -20dBm with a DC voltage of +6VDC on the RF input pin without permanent damage to the module.

3.3.3 Jamming Performance

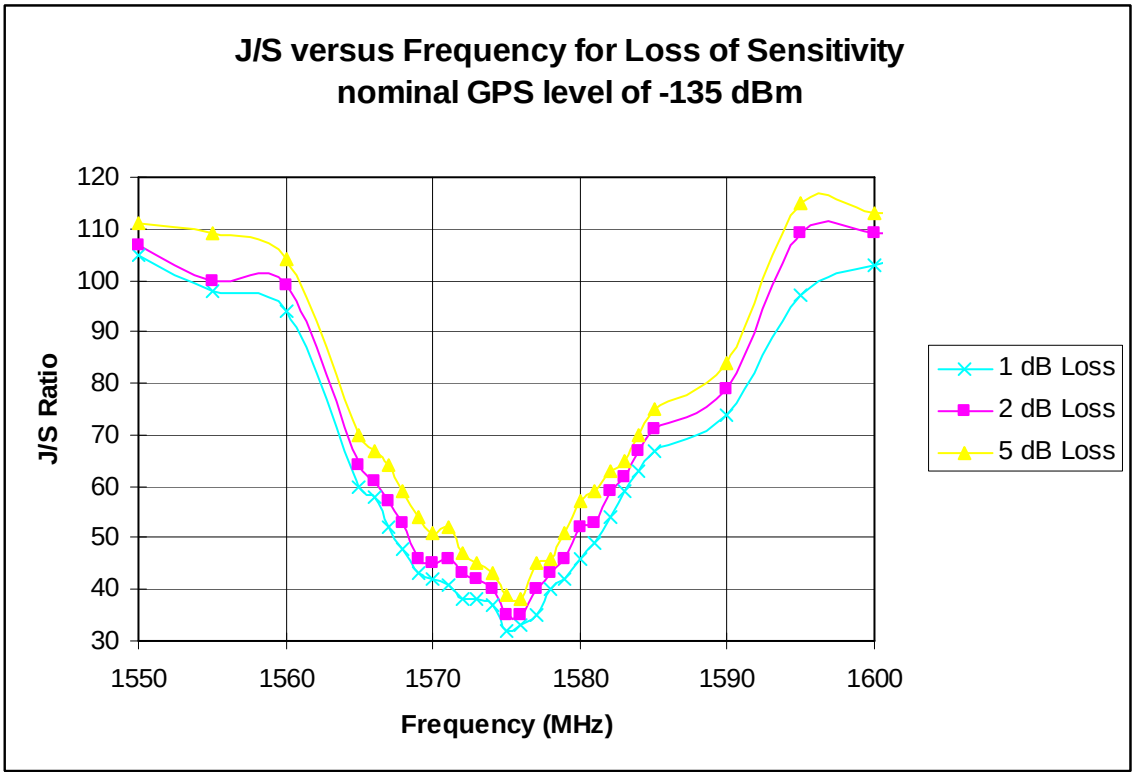


Figure 2 – Jamming Performance

3.4 Signal Interface

3.4.1 Digital Interface Levels

VCC is nominally 1.8 VDC.

VIH(min)	0.7 x Vdd
VIH(max)	Vdd + 0.3 Vdc
VIL(min)	-0.3 Vdc
VIL(max)	0.3 x Vdd
VOH(min)	0.8 * Vdd
VOH(max)	Vdd
VOL(min)	0 Vdc
VOL(max)	0.22 * Vdd

Table 10– Digital I/O Interface Levels

3.4.2 Serial Interface

Two serial data ports provide data communications to and from the MN1010 GPS Receiver Module.

3.4.2.1 Supported data formats and bit rates

The MN1010 data format is 8 bits, no parity, and 1 stop bit. The default bit rate is specified by the software loaded into flash. However, the user can change it from 4800 bps to 115kbps. During firmware reprogramming, the serial port defaults to 9600 bps upon reset if $\overline{\text{SERBOOT}}$ is pulled active (low).

4 Software Interface

4.1 Programming the on-board flash

The on-board flash device can be reprogrammed to update the firmware on the MN1010, or to replace the firmware with a customized version. The $\overline{\text{SERBOOT}}$ line, which is normally held in logic 1 (high) state, is pulled to logic 0 (low) and the power cycled or a reset issued.

The typical procedure for re-flashing the MN1010 is to use the MMT-supplied utility to verify proper connection to the device, then download a RAM based flash utility, which upon startup will change the bit rate to 115K bps, download the flash and then verify the flash contents.

Serial port 0 will issue a hexadecimal $55 (ASCII upper case U) at 9600 bps. MMT will supply a flash programming utility that runs on a standard PC-compatible machine running the Windows operating system. The procedure for reprogramming the flash consists of the following steps:

1. Pull $\overline{\text{SERBOOT}}$ line low.
2. Reset the MN1010 by power cycling or sending a reset signal.
3. Detect the hexadecimal $55.
4. Using the MMT flash utility, download the flash loader program into on-board RAM.
5. Using the MMT flash utility, erase the on-board flash.
6. Using the MMT flash utility, download the new firmware image and program into the on-board flash.
7. Pull $\overline{\text{SERBOOT}}$ line high.
8. Reset the MN1010 by power cycling or sending a reset signal.
9. If flash is programmed correctly, the MN1010 will execute the new software code.

4.2 NMEA Standard Output Messages

The MN1010 sends the following NMEA-018 v3.0 standard sentences:

ID	Description	Orion
DTM	Datum Reference	Y
GGA	GPS fix data	Y (D)
GLL	GPS Position – Latitude & Longitude	Y
GSA	DOP and active satellites	Y (D)
GSV	Satellites in view	Y (D)
RMC	Recommended Minimum GNSS Data	Y (D)
VTG	Course over ground and ground speed	Y
ZDA	Time and date	Y

D = Enabled by default

Table 11 – Standard NMEA Output Sentences

4.3 NMEA Proprietary Output Message

The MN1010 sends the following NMEA-0183 proprietary sentences:

Orion

ID	Description
echo	Echo of input command
$PUNV,CFG_R	Response to CONFIG command
$PUNV,ERR	Error response

Table 12 – Proprietary NMEA Output Sentences

4.4 NMEA Proprietary Commands

The MN1010 recognizes the following NMEA-0183 proprietary commands:

Orion

ID	Description
$PUNV,GETCONFIG	Read configuration parameters
$PUNV,CONFIG	Set configuration parameters
$PUNV,SLEEP	Enter sleep mode
$PUNV,START	Start Navigation
$PUNV,STOP	Stop Navigation

Table 13 – Proprietary NMEA Commands

For detailed information regarding these messages, please refer to the NMEA User Manual.

5 EMI/EMC

5.1 EMI Requirements

As the MN1010 is a component used on a circuit board assembly, it is not required nor is it specified to comply with EMI or EMC regulations.

5.2 Receiver Frequency Plan

The MN1010 implements a single down-conversion quadrature IF receiver which then is fed into the digital baseband processor.

Receiver Parameter	Specification
TCXO Frequency	16.3676 MHz
Local Oscillator Frequency	1573.874 MHz
IF Frequency	1. 54604 MHz
Baseband processor Clock Frequeny	16.3676 MHz

Table 14 – Receiver Frequency Plan

6 Power Supply Decoupling and Switching

Each power supply pin should by bypassed with a good quality RF ceramic capacitor resonant around 1.5 GHz. The 1.8-volt RF pin should be bypassed with a 27pF, 1000pf and 4.7uF capacitor to ground. This pin should be fed with an 18 ohm resistor to +1.8 volts.

If a switching power supply is used, it is important that the switching noise be kept below 50 mV peak-to-peak. As the switching frequency gets closer to the IF frequency, the switching noise will have to be further reduced to eliminate interference.

7 RTC Crystal Specification

Frequency	32.768 KHz
Type	Tuning fork crystal
Load capacitance	12 pf (see below)
Shunt capacitors	The series combination of the input and output shunt capacitor must equal the load capacitance for the selected RTC crystal. When calculating the capacitor values, it is important to consider the 3 pf per pin capacitance of the MN1010 device. The other end of the shunt capacitors must be tied for the +1.8-volt power supply to ensure proper RTC startup.

Table 15 – RTC Crystal Specs

8 Referenced Documents

MMT NMEA User Manual for Orion	
MN1010 Design Guidelines	
MN1010 Evaluation Kit User Guideline	

Table 16 – Referenced Documents for MN1010 Data Sheet

9 Packaging and Marking Information

9.1 Component Marking

Figure 3 – Marking

Note the JEDEC Pb-free symbol is also used as the pin 1 identifier for the MN1010.

9.2 Packaging Drawing

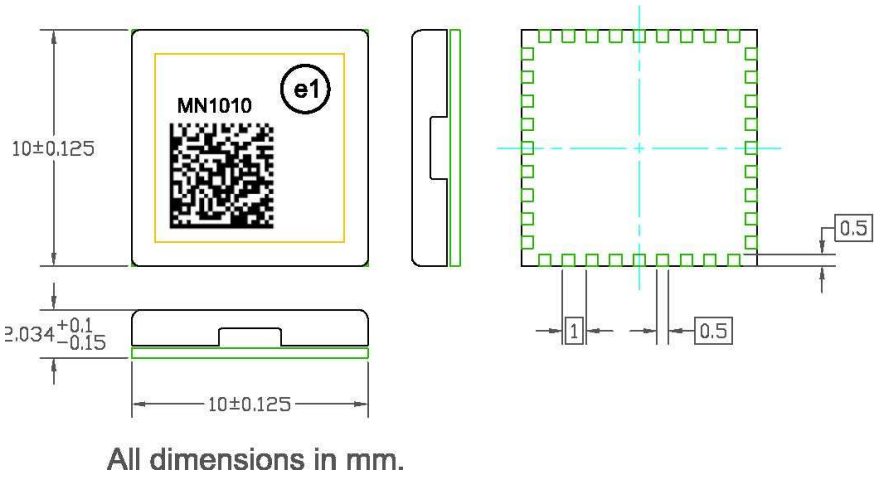


Figure 4 – Package Outline

Note the JEDEC Pb-free symbol is also used as the pin 1 identifier for the MN1010.

9.3 Recommended PCB Footprint

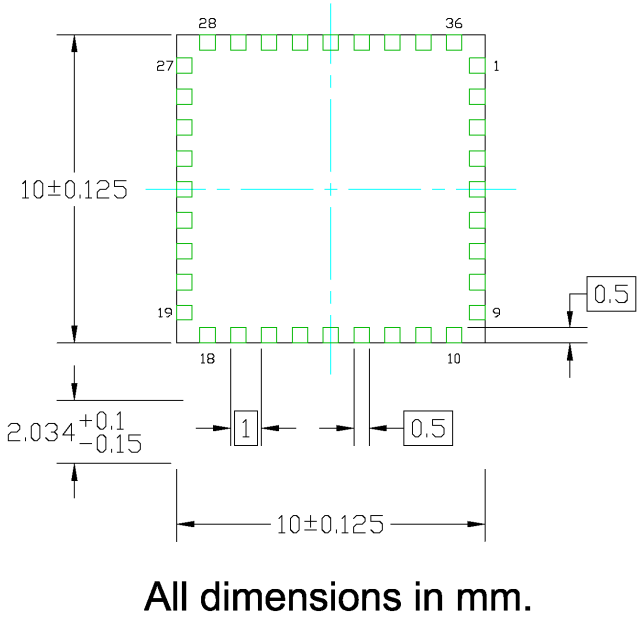
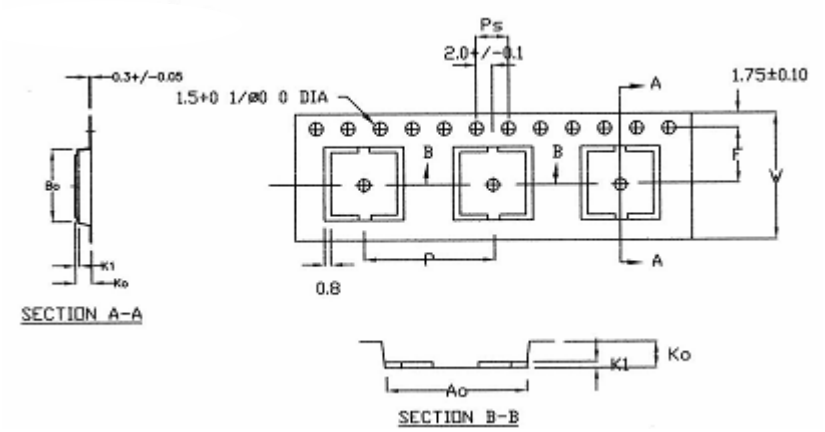


Figure 5 – Recommended PCB Footprint

Figure 5 is a suggested PCB footprint for the MN1010. The user may need to adjust the pad dimensions based upon their manufacturing process. While solder mask covered traces are permissible underneath the MN1010, exposed vias or pads should be avoided.

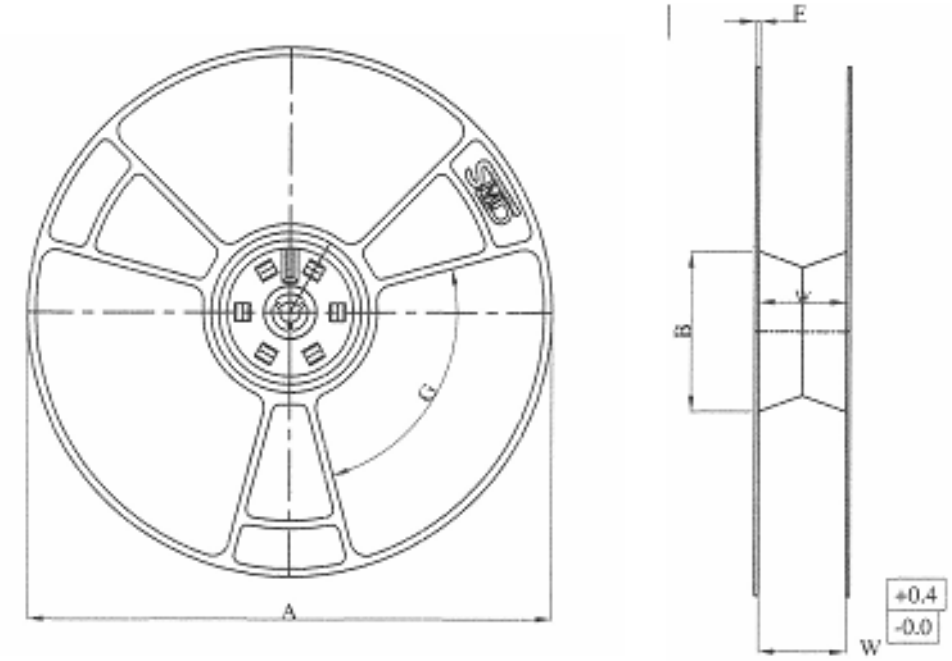
9.4 Tape and Reel Information

The MN1010HS is provided in standard tape and reel, with 2K devices per reel.



Dimensions	W	P	Ao	Bo	Ko	K1	Ps	F
Nominal	24.00	16.00	10.40	10.40	1.50	0.40	4.00	11.50
Tolerance	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Figure 6 – Carrier tape dimensions (in mm)



Reel Part No.	A	W	B	F	G
SMD/H4/W24	330	24.4	100	2.2	90°

Figure 7 – Reel Dimensions (in mm)

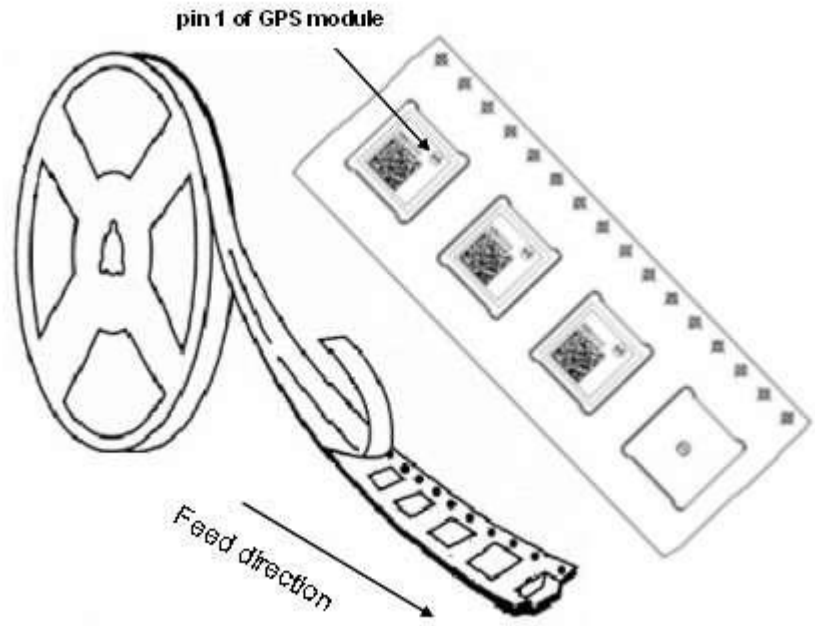


Figure 8 – Orientation in tape

9.5 Tube packaging

The MN1010 is also available in tube form, with 48 devices per tube. The length of the tube is 501mm ± 0.1mm.

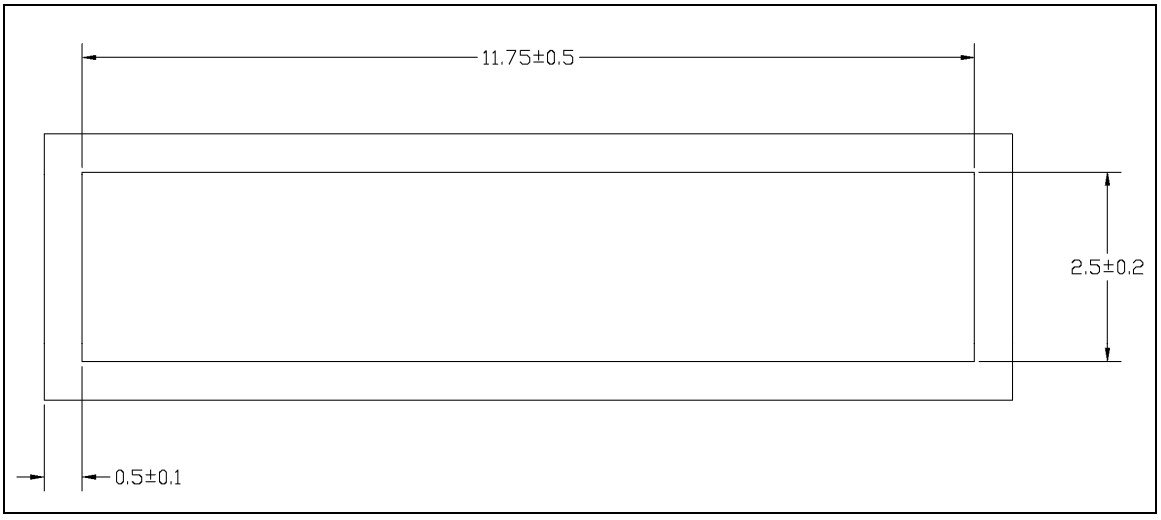


Figure 9 – Tube dimensions (in mm)

9.6 Recommended Reflow Profile

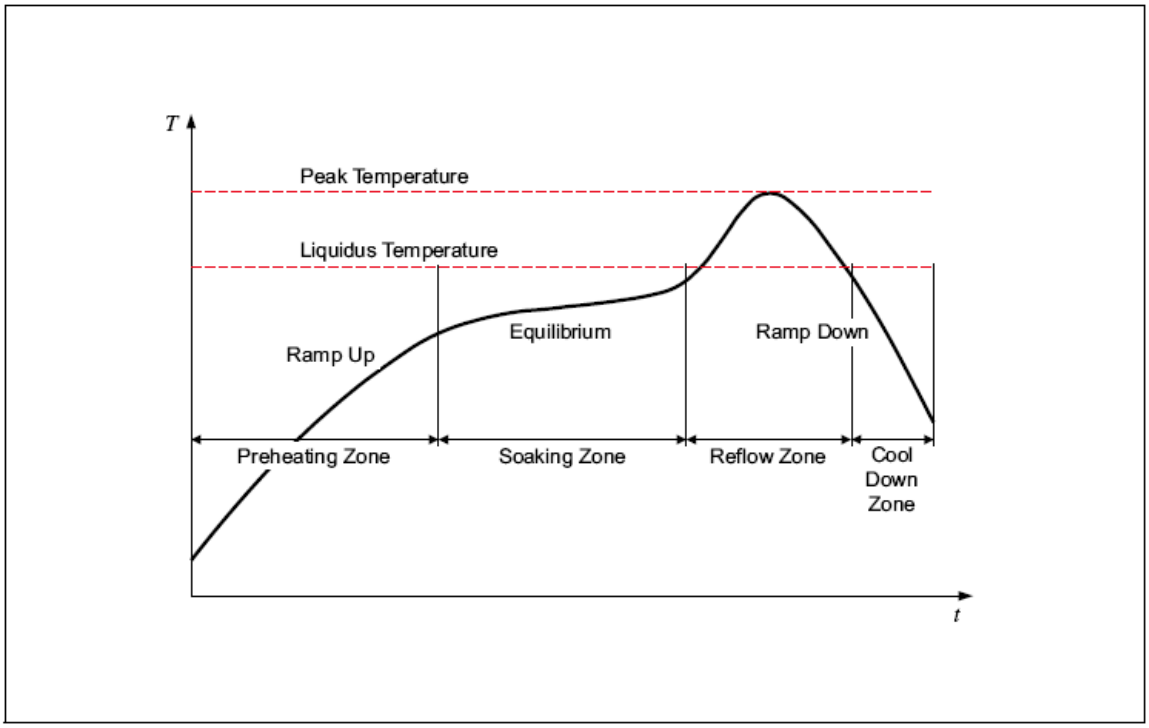


Figure 10 – Reflow Profile

Reflow Parameter	Specification
Preheating Rate	2.5℃/seconds
Soaking Temperature	140℃ to 170℃
Soaking Time	80 seconds
Peak Temperature	260℃
Reflow Time over Liquidus	60 seconds
Cool down Rate	2.5℃/seconds

Table 17 – Reflow Parameters

10 Ordering Information

The ordering part numbers are contained in the table below:

Ordering Part Number	Description
MN1010-RO	MN1010 in tape & reel with Orion Software
MN1010-TO	MN1010 in tube with Orion Software

Table 18 – Ordering Information

11 Notices

All reference and informational documents (including marketing information, specifications, reference designs, etc.) are provided for information only and are subject to change without notice. Reasonable efforts have been made in the preparation of these documents to assure their accuracy, however Micro Modular Technologies Pte. Ltd. assumes no liability resulting from errors or omissions in this, or any document, or from the use of the information contained herein. Micro Modular Technologies Pte. Ltd. reserves the right to make changes in the product design and specifications as needed and without notification to its users. Please check our website for the most current documentation. All information contained herein is the property of Micro Modular Technologies Pte. Ltd. and may not be copied or reproduced, other than for your information, without prior written consent.

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